Non-pharmacological interventions for reducing fear and anxiety in patients undergoing third molar extraction under local anesthesia: Systematic review and meta-analysis

Natalie Sui Miu Wong

The University of Hong Kong

Andy Wai Kan YEUNG

The University of Hong Kong

Kar Yan LI

The University of Hong Kong

Colman Patrick MCGRATH

The University of Hong Kong

Yiu Yan LEUNG (✉ mikeyleung@hku.hk)

The University of Hong Kong

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Abstract

Objective

To investigate the effectiveness of non-pharmacological interventions for reducing dental fear and anxiety in patients undergoing third molar extraction under local anesthesia.

Materials and Methods

Multiple electronic databases were searched for articles published in English. Inclusion criteria were randomized controlled trials reporting the effectiveness of any non-pharmacological interventions on reducing fear or anxiety level in patients with third molar extraction. A total of 3015 studies by electronic search and 2 studies by hand search were identified. After removal of duplication, screening of title and abstract, and assessment of full text, 21 studies were eligible for systematic review. Seven studies were included in the meta-analysis. A total of 1843 study participants composed the sample of the systematic review. Study selection, data extraction, and quality assessment of the included studies were performed by two independent investigators. Quality assessment was performed by using the Revised Cochrane risk-of-bias tool for randomized trials.

Results

The anxiety level after intervention in each study were pooled and meta-analyzed by random-effect model. Significant reduction of anxiety level was observed in non-pharmacological interventions groups (SMD = -0.32, 95% CI -0.57 to -0.07, $P = 0.01$). Subgroup analyses showed that a significant anxiety reduction by non-pharmacological interventions could be demonstrated by pooled data from studies using psychometric assessments, but not from studies using physiological assessments.

Conclusions

Non-pharmacological interventions appear to reduce fear and anxiety level in patient undergoing third molar extraction under local anesthesia.

Clinical Relevance:

Evidence suggests fear in third molar extraction bring negative impacts on both oral health and psychosocial well-being. The use of non-pharmacological intervention as an adjunct of local anesthesia should be considered in dental care setting.

Introduction

Dental fear and anxiety is omnipresent and there has been considerable interest in how to reduce dental fear and anxiety both by pharmacological and non-pharmacological interventions ¹. The terms of dental fear, dental anxiety and dental phobia are used interchangeably in literature. They are known psychological responses to uncomfortable or unpleasant stimuli but vary in the level of their severity. Fear is described as the immediate emotional response to an object, situation or threat, whereas anxiety is defined as an anticipation of future threat ². According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) ³, phobia is defined as a type of anxiety disorder when an individual has an excessive level of fear towards a specific situation or object which affects their daily functioning and quality of life.

Dental anxiety and its related influences

Dental fear and anxiety are common phenomena in the society and they have notable impacts to both patients and dental practitioners ⁴. Prior studies suggested that people with dental anxiety tended to have higher risk of experiencing oral disease, poor dental health, more missing teeth, and higher prevalence of toothache ⁵. In addition, fear and anxiety can act as invisible barrier for patients to seek oral health service. Some obvious behavior patterns include higher tendency to delay their dental treatment, and failure to show up in dental appointment ^{6,7}. As a result, psychological wellbeing and social functioning among individuals with a high level of dental anxiety are commonly affected ⁸, such as sleep disturbance, embarrassment of poor oral health status, feelings of low self-esteem, and decrease in both social interaction and participation in social activities ⁹. As these psychosocial-related mental processes, behaviour, and the progressive worsening of untreated oral health problems serve to reinforce and further intensify the level of fear, thus a vicious cycle is established. Therefore, effective management of dental anxiety is desired for both patients and dental practitioners.

Pharmacological and non-pharmacological intervention in reducing fear in dental procedures

Pharmacological approach is a traditional way to manage pain and dental anxiety, they are considered as conventional treatments. Pharmacological interventions include pre-extraction medication, local anesthesia, and sedation. However, the use of drug-related methods may bring adverse effects in risk patients and patients with medical history, such as nausea, dizziness, tachycardia, and other complications ¹⁰. In regard to reducing undesirable emotional, physical, and behavioral responses of patients evoked by fear and anxiety, non-pharmacological interventions were applied as an adjunct in standard dental procedures. Existing approaches can be broadly categorized into psychological interventions (such as cognitive, behavioral, cognitive-behavior interventions, hypnosis, distraction and relaxation) ¹¹⁻¹⁴, and other non-pharmacological interventions (such as enhanced pre-operative information, music listening, and virtual reality) ¹⁵⁻¹⁹.

Rationale and objectives

With the high prevalence of dental fear worldwide²⁰, reducing level of fear and anxiety in dental care procedures is desirable for both patients and dental practitioners. The use of non-pharmacological interventions as an adjunct of pharmacological treatments have been increasingly supported by recent systematic reviews^{21–23}. However, most of the review addressed on reducing anxiety in a general dental care procedure, while some of these reviews focus exclusively on psychological interventions. Owing to the fact that third molar extraction is one of the most common clinical procedures in oral surgery, and suggested to trigger fear the most when compared to other dental procedures or minor oral surgery procedures²⁴. It was estimated that approximately every one in four dental patients had an impacted lower third molar²⁵. Nearly one-quarter of them required general anesthesia or conscious sedation during surgical removal of the third molar²⁶. In general, the use of general anesthesia would increase the cost by at least 14% in medical treatments²⁷. The economic burden for the society could be effectively reduced if non-pharmacological interventions could reduce patients' anxiety level and hence switching them from undergoing general anesthesia to local anesthesia. Therefore, a comprehensive review focus particularly on the process of third molar extraction is essential. The present systematic review of randomized controlled trials aimed to investigate the effectiveness of non-pharmacological interventions for reducing fear and anxiety in patients that are implementable for third molar extraction, and to compare the efficacy without non-pharmacological or treatment as usual or with local anesthesia alone in third molar extraction.

Methods

The study was reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines²⁸.

Identification of studies (PICOS) and eligibility criteria

The inclusion criteria were defined according to PICOS framework. Patients (P) – Patients undergoing third molar extraction with aged 18 years or older were considered. Patients aged under 18 years were excluded as the assessment measures were different from adults. Interventions (I) – Any non-pharmacological intervention which aimed to reduce stress, fear or anxiety, implemented either before or during extraction procedures. Any non-pharmacological interventions act as an adjunct to local anesthesia, with or without sedation, were included. Comparators (C) – All relevant control interventions were included, such as standard treatment care, treatment as usual (no intervention implemented) and placebo. Outcomes (O) – Any physical or psychological outcome explored were considered. Trials measured mental state, stress, fear, or anxiety through validated assessment tools including self-reported or observer-reported were included. Trials measured phobia were excluded, as phobia is a clinical diagnosis, which affects and limits individuals' daily functioning. Study design (S) – Randomized clinical trials were included into the systematic review, but only randomized controlled trials were included into the meta-analysis.

Information sources, search strategy and study selection

Electronic literature search was carried out in the databases Cochrane, EMBASE, MEDLINE, PsycInfo, PsycArticles, PubMed, and Web of Science. The search strategy is shown in Appendix A. The last search was performed in November 2020. Reference lists of relevant publications were screened. Titles and abstracts of eligible studies were reviewed by two investigators (NW and AY) independently. A hand search of the references list in included articles were performed in the second-round search.

Disagreements were noted and resolved by discussion with a third investigator.

Data extraction

A predefined data extraction sheet was developed. Two investigators (NW and AY) independently review the full text of articles. One author performed data extraction and the second author checked the extracted data. Disagreements were resolved by discussion and reaching consensus. Data from included studies were collected: authors, publication year, journal, country, characteristics of participants (including age and experiences of oral surgery), characteristics of trials (including sample size, number of surgeons involved in the study, type of intervention, group classification, time for intervention, the use of anaesthesia, duration of surgery, measurement for variables, time for measurement, and major findings.

Study quality assessment of individual studies

Quality assessment of the included studies were assessed by using the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2) ²⁹ with five domains: (1) the risk arising from the randomization process, (2) bias due to deviations from intended interventions, (3) bias due to missing outcome data, (4) bias in measurement of the outcome, and (5) bias in selection of the reported result. Risk of bias assessment was conducted by two independent reviewers (NW and AY), consensus was reached with discussion.

Summary measures and data synthesis

The primary measure of the treatment effect was the reduction of fear and anxiety level. Meta-analyses were performed using Review Manager (Version 5.4, The Cochrane Collaboration, 2020). Standardized mean difference (SMD) was used as the effect measure in meta-analysis because different studies measured the outcome by use of different psychometric or physiological assessment scales. Outcome data were analyzed using random effect model with 95% confidence interval (CI). Substantial heterogeneity between trials was assessed by χ^2 test with $P < 0.10$ and the I^2 statistic of $> 50\%$ ³⁰. If the above two criteria were not fulfilled but I^2 statistic still ranged from 30–50%, then heterogeneity was still defined as moderate heterogeneity ³⁰. When I^2 statistic $< 30\%$, heterogeneity might not be important.

Risk of bias across studies

Examination of publication bias were not performed, as only seven studies were eligible for meta-analysis ³¹.

Results

Overall, 3015 potentially relevant articles were identified through database search, and 2 more publications were identified through other sources. 2976 of article were excluded after removal of duplication and abstract screening. A total of 41 publications were retrieved for full-text review, 21 trials met the inclusion criteria and were included in the systematic review^{13,15,19,32-49}. Figure 1 showed the flowchart of the study selection process recommended by the PRISMA Statement. Characteristics of included studies were presented in Table 1. Agreement between two reviewers was identified the following two phases: (1) title and abstract screening, and (2) full-text screening, with Kappa coefficient level of agreement 84.2% and 82.8% respectively.

Risk of bias within studies

Risk of bias varied across 21 included publications. Eight studies were judged as low risk of bias, 8 studies had some concerns, and the remaining 5 studies were at high risk of bias. The completed risk-of-bias assessments for each study is summarized in Figure 2.

Characteristics of included studies in systematic review

General characteristics. All studies included were published in English between 1992 to 2020 (Table 1). Those 21 trials were conducted in Turkey (n = 5), the US (n = 4), Brazil, Iran, Japan, and Korea (each n = 2), and India, Israel, Netherland, and Saudi Arabia (each n = 1). They were all randomized clinical trials published in scientific journals. 15 of them were identified as randomized controlled study, and 6 of them were randomized clinical study. Among those 3 randomized clinical studies, 1 was a split-mouth study, 2 were crossover studies, and 3 were clinical studies without control group.

Study participants. The number of participants per study ranged from 16 to 300, with a total of 1849 study participants in the review. All studies recruited both males and females, except 2 study were all-female and 1 study did not provide related information. The mean age of participants ranged from 22 to 35 years among all studies. Only 7 studies reported previous oral surgery experiences of patients.

Study design. The most frequently investigated interventions were enhanced preoperative information (n = 8) and music listening (n = 3) (Table 2). Meanwhile, two studies carried out multiple comparisons with different approaches, namely oral premedication, relaxation, self-efficacy enhancement, and intravenous needle desensitization. Interventions in 15 studies were applied before surgical procedures, while five interventions were applied during surgical procedures, and one study did not provide information. Among 21 studies, the use of local anesthesia in surgical procedure were reported in 11 studies, the use of sedation in 2 studies, and the use of anesthesia and sedation together in 1 study. Only 7 studies recorded the duration of surgical procedure. The mean surgery time ranged from 16.32 to 41.4 minutes (Table 1).

Table 2
Category of non-pharmacological interventions of included studies in systematic review.

Interventions	n
Enhanced preoperative information	8
Form of delivery (n = 7)	
Content of information (n = 1)	
Music listening	3
Smell / Odor	2
Hypnosis	2
Auriculotherapy	1
Acupuncture	1
Virtual reality	1
Separate day of consultation	1
Comparisons between oral premedication, relaxation, self-efficacy enhancement, and intravenous needle desensitization	2

Measurements. Mental distress and anxiety of patients were primarily measured by patient-reported psychometric assessments and physiological assessments. Ten studies investigated anxiety by psychometric assessments only, 1 study investigated by physiological assessments only, and 10 studies investigated with both assessments. The psychometric and physiological assessments employed among those 21 studies are listed in Table 3. The most frequently used psychometric and physiological measurements were State-Trait Anxiety Inventory (STAI) and blood pressure (BP) respectively.

Table 3
The use of measurement tools of included studies in systematic review.

Measurements	n
Psychometric Assessments	
State-Trait Anxiety Inventory (STAI)	10
Modified Dental Anxiety Scale (MDAS)	6
Dental Anxiety Scale (DAS)	5
Visual Analogue Scale (VAS)	5
Dental Fear Survey (DFS)	2
Numerical Rating Scale (NRS)	2
Patient Stress Response Index (PSRI)	2
Amsterdam Preoperative Anxiety and Information Scale (APAIS)	1
Dental Anxiety Questionnaire (DAQ)	1
Short form Dental Anxiety Inventory (S-DAI)	1
Short version of Fear of Dental Pain Questionnaire (S-FDPQ)	1
Physiological Assessments	
Blood pressure (BP)	9
Heart rate (HR)	7
Blood oxygen saturation (SpO ₂)	4
Respiratory rate (RR)	3
Pulse rate (PR)	2
Heart rate variability (HRV)	3
Electrodermal activity (EDA)	1

Outcomes. The primary outcome of all studies was ‘changes of anxiety’ from baseline to after the implementation of non-pharmacological interventions. Secondary outcomes were included in some studies, including pain level, analgesics used, satisfaction, episodes of vomiting, nausea, trismus, oedema, level of coping self-efficacy, and other complications.

Results of individual studies and syntheses of results

Meta-analysis results were shown as forest plots of SMD and its 95% CI. A total of fourteen studies were excluded. Thirteen studies were excluded because changes of mean or SD were not available and one of the studies was excluded because it did not have a control group. Studies presented with high risk of bias were initially included, but no numerical data of these studies were available in the meta-analysis. Complete data were available for 7 studies (Figure 3). Compared with all control groups, the anxiety level of non-pharmacological intervention groups was reduced by 0.32 units. A significant reduction in anxiety level was found (SMD = -0.32, 95% CI -0.57 to -0.07, $P = 0.01$). Random effect model was applied, as substantial heterogeneity ($P = 0.003$, $I^2 = 70\%$) of included studies was observed. One study was identified by retrospective exploration of heterogeneity and excluded in second round analyses. Low heterogeneity was detected ($P = 0.36$, $I^2 = 9\%$) after removing the study, and the finding was not affected (SMD = -0.18, 95% CI -0.32 to -0.04, $P = 0.01$), anxiety level was significantly decrease in non-pharmacological interventions groups compared with control groups.

Additional subgroup analyses

Multiple subgroup analyses were carried out, as timing of delivering non-pharmacological interventions varied among included studies. Some interventions were delivered before third molar extraction while some were delivered during third molar extraction. In addition to the timing of intervention delivery, form of anxiety assessments was also considered as a factor influencing the result. Assessment of anxiety were categorized into psychometric assessments (i.e. self-administered questionnaires) such as Corah's Dental Anxiety Scale (DAS) and Kleinknecht's Dental Fear Survey (DFS), and physiological assessments (i.e. vital signs) such as hear rate (HR), blood pressure (BP), and respiratory rate (RR). Therefore, subgroup analyses were performed: (1) effectiveness of non-pharmacological interventions between groups with interventions applied before and during third molar extraction, and (2) effectiveness of non-pharmacological interventions between groups with psychometric and physiological assessment.

Interventions applied before vs. during third molar extraction. Subgroup analyses were carried out. Among the 7 included studies, non-pharmacological interventions were applied before third molar extraction in 4 studies, and during third molar extraction in 3 studies (Figure 4). The effect of applying non-pharmacological interventions before third molar extraction was not statistically significant (SMD = -0.20, 95% CI -0.44 to -0.03, $P = 0.09$). Heterogeneity of effect was moderate ($P = 0.17$, $I^2 = 41\%$). The effect of applying non-pharmacological interventions during third molar extraction was also not statistically significant (SMD = -0.51, 95% CI -1.08 to 0.06, $P = 0.08$). Heterogeneity was substantial ($P = 0.001$, $I^2 = 85\%$). After removing one identified distinctive study to reduce the heterogeneity, the finding was still not affected (SMD = -0.17, 95% CI -0.38 to 0.04, $P = 0.11$); no heterogeneity was detected ($P = 0.53$, $I^2 = 0\%$). The effect of applying non-pharmacological interventions during third molar extraction did not produce a statistically significant effect.

Psychometric assessments vs. Physiological assessments. Comparison between psychometric and physiological assessments were carried out (Figure 5). Compared with all control groups, the data in six studies with using psychometric assessments presented a significant reduction in anxiety level (SMD =

-0.18, 95% CI -0.32 to -0.04, $P = 0.01$). Low and possibly not important heterogeneity was detected ($P = 0.36$, $I^2 = 9\%$). However, data in three studies using physiological assessments did not produce a significant reduction in anxiety level (SMD = -0.28, 95% CI -1.07 to 0.52, $P = 0.50$). Heterogeneity was substantial ($P < 0.001$, $I^2 = 93\%$) (Figure 5). Result was not affected after removing the identified distinctive study to reduce the heterogeneity (SMD = 0.20, 95% CI -0.16 to 0.56, $P = 0.27$). Heterogeneity was moderate ($P = 0.10$, $I^2 = 62\%$). Studies using physiological assessments did not identify significant reductions in dental anxiety.

Discussion

This meta-analysis identified that non-pharmacological interventions can generally reduce dental anxiety for patients undergoing third molar removal. This effect could not be shown when the studies were divided into interventions before and during third molar surgery. Subgroup analyses also demonstrated that the reduction in dental anxiety could be effectively reflected by psychometric but not physiological assessments. This was a novel finding, as prior meta-analysis on non-pharmacological interventions for general dental treatment only reported an overall effect without distinguishing psychometric and physiological properties ²¹.

Inventory used to measure dental anxiety

It was found that the most frequently used inventory to measure dental anxiety was State-Trait Anxiety Inventory (STAI) ⁵⁰, which is a scale for measuring general current state of anxiety toward a situation or an event (i.e. state), and the tendency of individual to experience anxiety symptoms (i.e. trait), but not specified for measuring dental anxiety. Other inventories commonly recruited by the reviewed studies were dental anxiety specific, such as (Modified) / Dental Anxiety Scale (MDAS / DAS) ^{51,52} and Dental Fear Survey (DFS) ⁵³. However, these inventories were constructed without theoretical basis. Most of these scales focus on specific dental stimuli only, while components such as cognitive, behavioral, and physiological aspects being overlooked ². Besides, these scales were being criticized for poor construct validity ⁵⁴, unlike the Index of Dental Anxiety and Fear (IDAF-4C⁺), a theoretically-based psychological scale for measuring dental fear and anxiety⁵⁵.

Moreover, only two studies recruited patients with high dental anxiety according to the scores of Dental Anxiety Scale (DAS) or Dental Anxiety Questionnaire (DAQ) (Table 1), whereas other studies did not impose such inclusion criterion. Lastly, no study involved a clinical psychologist to diagnose whether the recruited patients had anxiety or not.

Quality of Evidence

The risk of bias assessment showed that nearly a quarter (5/21, or 23.8%) of the reviewed studies were of high risk. This situation was more severe compared to a prior systematic review on non-pharmacological interventions for anxiety reduction in general dental procedures (10.3% high risk studies) ²¹. The high-risk

studies mainly failed in domain D5 (Bias in selection of the reported result). All five studies mentioned that they had recorded the anxiety level by some rating scales and/or physiological data such as heart rate and blood pressure, but without complete reporting in their results section (Figure 2). One study failed in domain D2 (Bias due to deviations from intended interventions) - researchers switched two patients who refused to be in one intervention group to another intervention group without re-balancing the group compositions. This action caused deviations from intended interventions without appropriate compensation. One study failed in domain D4 (Bias due to measurement of the outcome), as it did not compare all outcomes with control group.

Limitations

The number of eligible studies to be meta-analyzed was limited. It was because some studies reported whether the results were significant or not (p -values) only, whereas the actual data of mean and SD were not available. For instance, the subgroup meta-analysis on physiological assessments composed of three studies only (Figure 5), rendering it difficult to ascertain the effectiveness of non-pharmacological intervention on them. Besides, some studies presented results in graphs or charts only, for which numerical data could not be extracted accurately and hence excluded from the meta-analysis. All of the above made it impossible to quantify the efficacy of each type of non-pharmacological interventions independently.

Future Directions and Implications

Prior unpleasant dental experience might condition a patient and make patients more anxious during a dental treatment⁴. On the contrary, patients with prior tooth removal experience might experience less anxiety due to less uncertainty. Meanwhile, the working experience of the operating surgeons might affect the outcome, as inexperienced dentists might spend more time to complete the third molar surgery, potentially heightening the dental anxiety level of the patients⁵⁵. All these potentially influential factors were seldom reported in the studies reviewed in this report. In addition, some of the non-pharmacological interventions were applied several weeks before the day of operation. The duration between interventions applied and day of surgery may become a factor influencing the efficacy of non-pharmacological interventions in reducing anxiety. Finally, the non-pharmacological interventions adopted in the reviewed studies were mainly operator-driven with patients receiving them passively. Future studies should consider in the following two aspects: (1) to apply more patient-driven interventions such as biofeedback, for which patients would try to maintain their physiological measures at a baseline level (e.g. breathing rate, heart rate) by receiving visual or audio feedback; (2) inventory with more solid theoretical basis in psychology could be deployed to assess dental anxiety.

Conclusion

Non-pharmacological interventions appear to offer promising ways to alleviate dental anxiety for patients undergoing third molar removal. Their effect could be demonstrated by psychometric but not physiological assessments. Future studies should report more numerical data apart from statistical

significance, as well as background information of both patients and surgeons in terms of prior dental experience particularly with third molar surgery. These measures should improve the current issue of having few eligible studies to be meta-analyzed.

Declarations

Data Availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions

Conceptualization: NSMW, Literature search: NSMW, Data analysis: NSMW, KYL, Writing the draft: NSMW, AWKY, Revise and editing: NSMW, CPM, YYL

Competing interests

The authors declare no competing interests.

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Tables

Due to technical limitations, table 1 is only available as a download in the Supplemental Files section.

Figures

Figure 1

Flowchart of identification, screen and assessing studies for inclusion eligibility

Study	D1	D2	D3	D4	D5	Overall
Ader et al. (1992)	!	!	+	!	+	!
Alfotawi et al. (2019)	!	-	+	!	-	-
Armond et al. (2019)	+	+	+	+	+	+
Casap et al. (2008)	!	!	!	-	+	-
Choi et al. (2005)	!	+	+	+	+	!
Dellovo et al. (2019)	+	+	+	+	+	+
Ghoneim et al. (2000)	!	!	!	+	-	-
Hasheminia et al. (2014)	+	+	+	+	+	+
Karan (2019)	!	+	+	+	+	!
Kim et al. (2011)	!	+	+	+	+	!
Kupeli et al. (2020)	!	!	!	+	-	-
Omezli et al. (2020)	+	+	+	+	+	+
Litt et al. (1993)	!	!	!	+	+	!
Litt et al. (1995)	!	!	!	+	+	!
Kazancioglu et al. (2015)	+	+	+	+	+	+
Peimani et al. (2017)	!	!	!	+	+	!
Saincher et al. (2019)	+	+	+	+	+	+
Tanidir et al. (2016)	+	+	+	+	+	+
Van Wijk et al. (2008)	!	+	+	+	+	!
Yamashita et al. (2019)	+	+	+	+	+	+
Yamashita et al. (2020)	!	+	+	+	-	-

Figure 2

Quality assessment of included studies in systematic review. Risk-of-bias judgments fall into three categories across five domains, with (+) being low risk, (!) being some concerns, and (-) being high risk. The five domains were as follows: (D1) Bias arising from the randomization process; (D2) Bias due to deviations from intended interventions; (D3) Bias due to missing outcome data; (D4) Bias in measurement of the outcome; and (D5) Bias in selection of the reported result

Figure 3

Forest plot of comparison: Changes of anxiety level in non-pharmacological interventions compared with control groups after third molar extraction

Figure 4

Forest plot of comparison: Sub-group analyses – Changes of anxiety level between groups with non-pharmacological interventions applied before and during third molar extraction

Figure 5

Forest plot of comparison: Sub-group analyses – Change of anxiety level between groups with psychometric assessments and physiological assessment after third molar extraction

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [AppendixA.pdf](#)
- [PRISMA2020checklist.docx](#)